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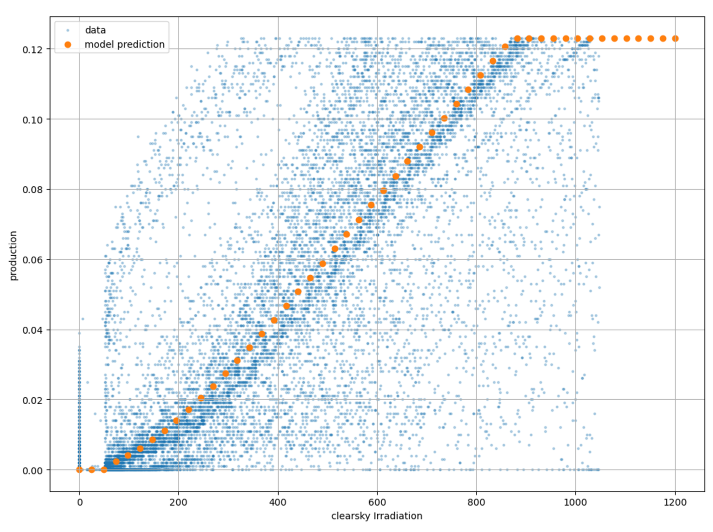
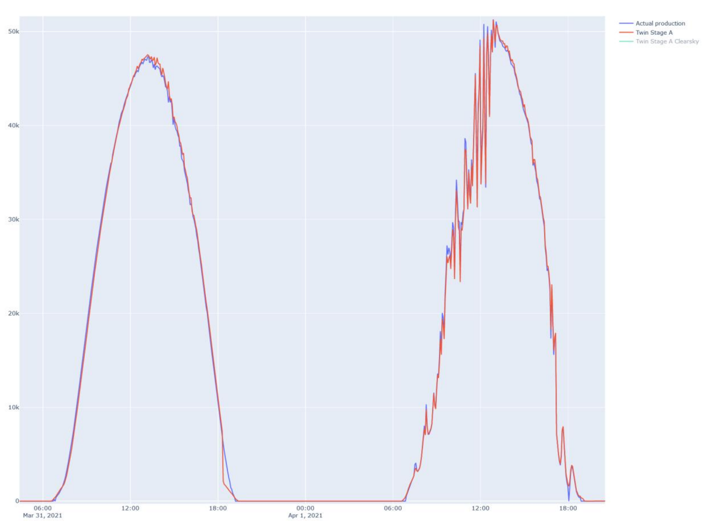
ERROR SOURCES IN PV PROGNOSIS

Motivation

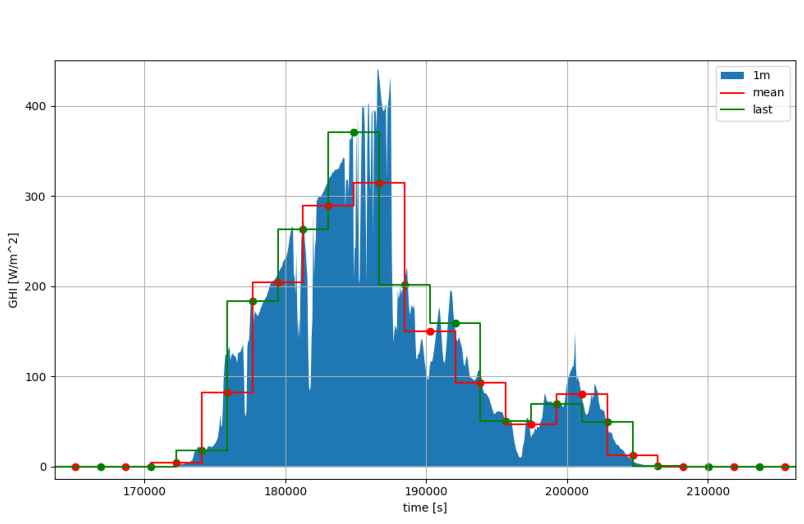
When forecasting the yield of Virtual Power Plants for the following day, there are often deviations between the forecast and the actual production. These are typically caused either by the modeling or by the in the weather forecasting.

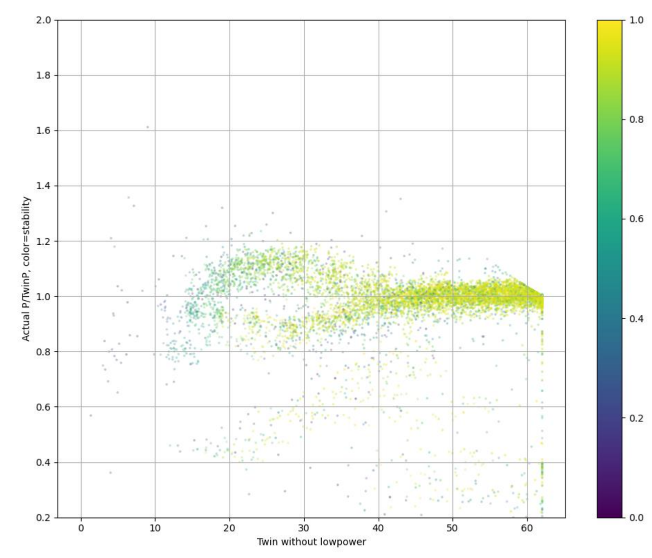
Digital Twin



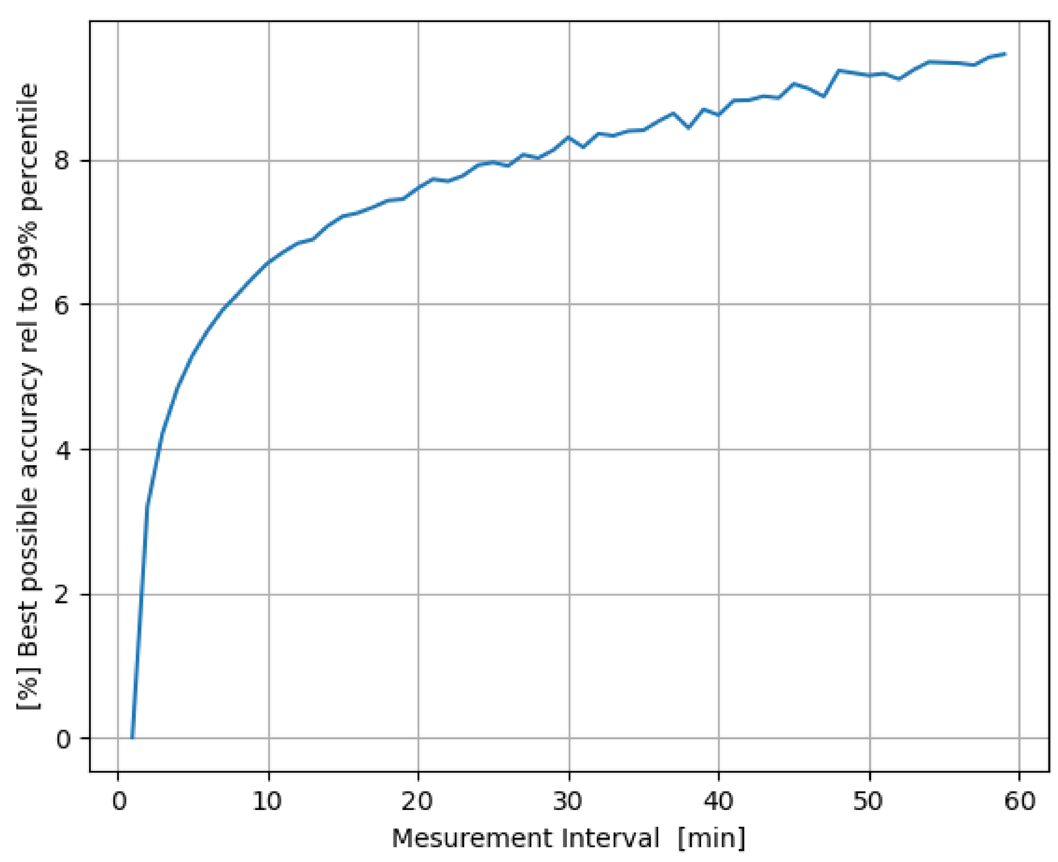


In PV systems, operating data is normally recorded. If the historical irradiation is known, digital twins of the energy production can be created. Divergences between real yield and twins occur primarily at times when sudden changes in irradiance exist. Monitoring data is stored only at discrete intervals. DC currents/voltages are often logged as instantaneous values to include MPP tracking information.
DC powers, on the other hand, are more useful averaged over the time domain. This causes a time offset of half an interval, which, uncorrected, leads to a distinct band structure between morning and afternoon, as irradiance is systematically over- or underestimated.



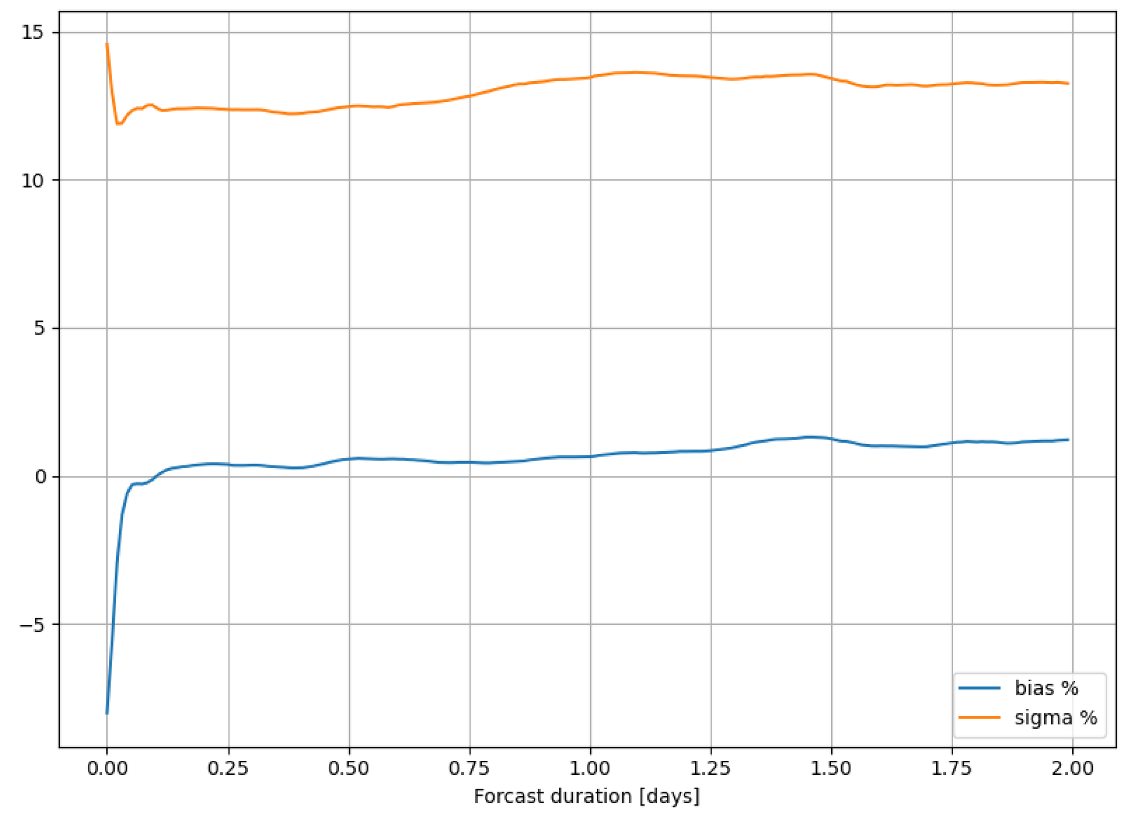


This time shift is correctable, but not the error caused by the temporal discretization of irradiance measurements. By means of a minute-by-minute horizontal irradiance measurement over four years in Vienna, the average deviation of an averaging irradiance measurement to an instantaneous use was quantified. Many weather stations for PV systems balance non-averaging. Even the forecast of a digital twin cannot compensate for systematic errors of the learning data.

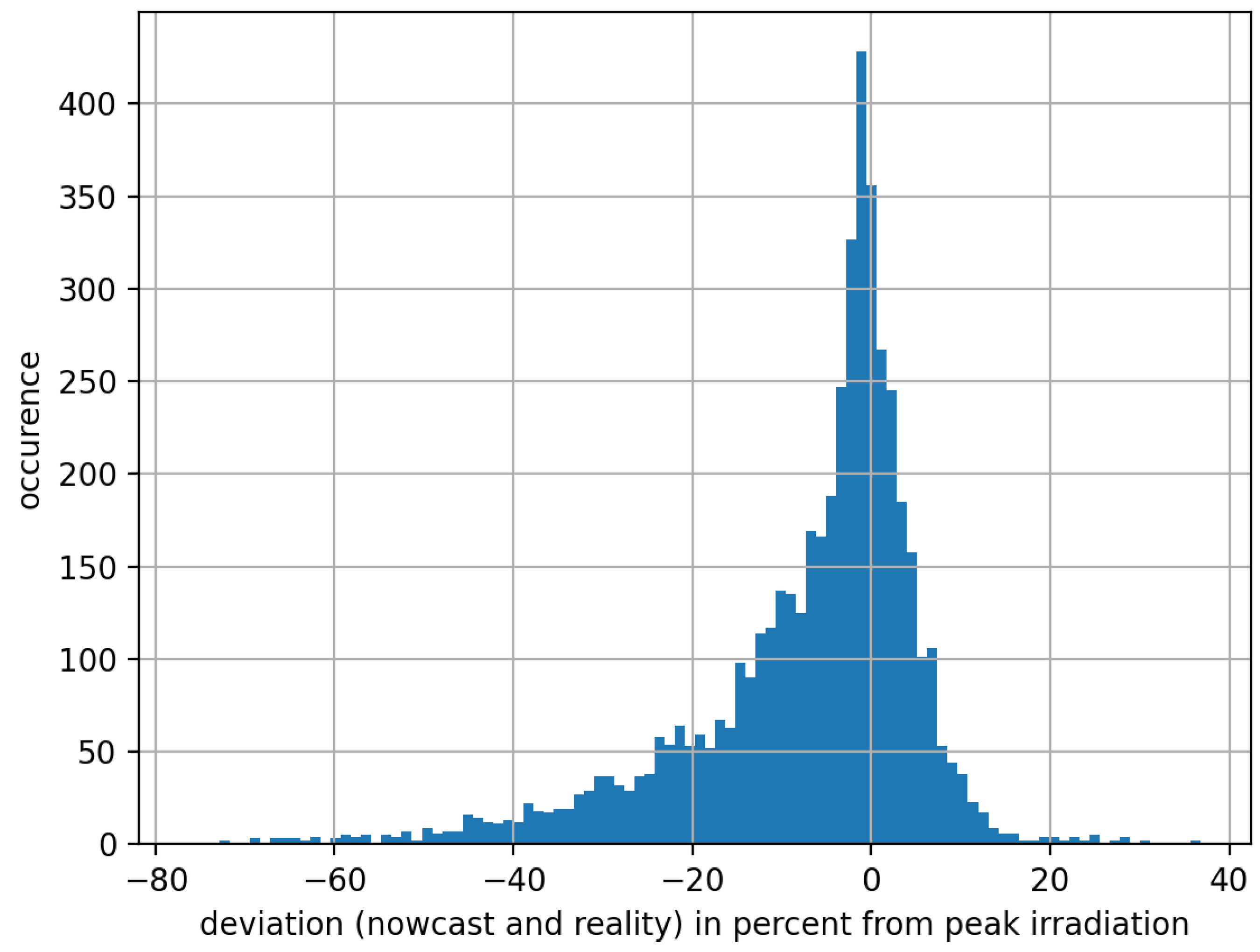


Irradiation Forecasts

Commercial irradiance forecasts at 15-minute intervals were accumulated over eight months, and compared to a ground-based irradiance measurement.



It turns out that the peak normalized standard deviation is not a good measure of the error deviations. These are by no means normally distributed, but show asymmetric distributions.



Surprisingly, the forecast quality hardly changes over two days, while only the short term forecasting exhibits stronger deviations.

Virtual Power Plants

One could now hope to achieve an improvement in the accuracy of the forecast by using a spatially distributed ensemble, analogous to common error propagation with $O(\sqrt{n})$. However, this would only work for independent normal distribution deviations. Using real data, an ensemble of five plants, in independent weather influence zones of eastern Austria was considered. The VPP output was 2.25 times that of the largest single plant. Even with high ensemble size, the limit of forecast accuracy is the offset of the forecast, as well as the correlation of individual errors.

	average individual System	VPP	VPP of normalized plants	Ideal Error propagation
TAWES	16.7%	10.6%	9.2%	9.53%
G Nowcast	17.6%	13.0%	10.7%	10.05%
G Dayahead	17.4%	11.6%	11.2%	9.93%

[1] B. Kubicek, M. Steinbrecher, M. Rennhofer, “Estimating day ahead photovoltaic production distribution function for the risk assessment of control energy provision.“, EU-PVSEC 2021.

This initiative has received funding from the European Union's Horizon 2020 research and innovation programme under the project REgions and the Austrian National FFG project APOLLO 897349.